Independent Peer Review Report on the NWFSC Southern California Shelf Rockfish Hook and Line Survey, held, 4-5 April 2012, in Seattle, Washington.

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Prepared for

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Executive Summary

I found the review of the Southern California Shelf Rockfish Hook and Line Survey an interesting review, with the overarching conclusion that the survey provided substantial information on the abundance and spatial distribution of reef-associated rockfish in the Southern California Bight (SCB) area. Bocaccio and vermillion rockfish (complex) are strongly structure-orientated species, as to a lesser extent are greenspotted rockfish, so these species tend to be poorly and inconsistently sampled during trawl surveys. The resultant paucity of fishery-independent information in the assessments has led to concerns regarding spatial and/or temporal biases in the assessments. The hook and line survey was specifically developed to address these concerns.

The review demonstrated the existence of spatiotemporal patterns in the distribution of bocaccio and vermillion rockfish within the available data series from the survey, suggesting that the survey was tracking population trends within the survey area. However, the cause of these trends or their link with absolute population abundance over time appeared currently to be poorly understood. The survey is carried out in a fixed-station manner, because such a method tends to produce more reliable and consistent results. However, the improvement in precision may be at the cost of bias in the mean predictor if the samples are not representative of the population. Significant safeguards against such biases have been included in developing the sampling methodology, in the form of design variables (sites, hook, drop, vessel, etc.) and control variables (continuous variables that cannot be specified practically in the sampling process, state of tide, lunar phase, percentage solar-day, or only partially constrained such as the time to retrieval). Such covariables can be retained in GLM models describing the probability of obtaining a fish on a specific hook and, provided the distribution of the covariables does not change significantly between years and colinearity is insignificant, the models should provide robust estimates.

The results of the survey were used to model the probability of one of the five hooks of one of the three gangions deployed on one of the five drops being occupied on retrieval by a rockfish of a specific species. Clearly, such a probability (presence/absence) is unlikely to be related linearly to abundance over the entire range of stock size, yet over a sufficiently small range of stock sizes it is likely to be appropriately reflected by a linear relationship. However, it is not clear what the range of stock size is intended for monitoring, nor where on the sigmoid curve the stock is currently situated, both of which influence the appropriateness of the linear approximation between probability and abundance and the level of change in abundance that may be detectable.

Length frequency information on Bocaccio and to a lesser extent Vermillion rockfish implied some variation in cohort strength or internal age-based consistence of the index information. However, this could not be confirmed directly, because growth in these species is variable and overlap of lengths between ages is great past the first few ages, and real age information is not available although otoliths are sampled. Age determination for the available time-series should

be carried out with priority to confirm the utility and consistence of the survey index, through examination of its internal consistence.

As there is little fishery-independent information available, the survey clearly represents the best scientific information available. However, more work needs to be done with respect to the use of binomial predictors in SS3 models and the potential for colinearity in survey control variables and spatial shifts in the distribution of the population between years to be included falsely in the year effect. The assessment of whether survey information on species other than those presented at the workshop and in areas beyond the current survey provides useful information for stock assessment, because requests from reviewers can only be made on theoretical grounds and essentially assume similar conditions for other species and other locations. Whether such assumptions are appropriate is best determined by either the stock assessment practitioners themselves or a review panel with more expertise specifically in the spatial distribution and biology of specific rockfish species along the west coast of the US.

1. Background

The purpose of the meeting was to provide an external peer review of the Northwest Fisheries Science Center's (NWFSC) Southern California Shelf Rockfish Hook and Line Survey. The survey was designed to collect fishery-independent data for groundfish associated with rocky habitats that are not sampled well by trawl surveys. Survey data are analysed to generate annual indices of relative abundance and time-series of biological data for use in the stock assessments for several species of shelf rockfish (genus *Sebastes*), including bocaccio (*S. paucispinis*) and greenspotted rockfish (*S. chlorostictus*).

The CIE (Center for Independent Experts) reviewer was tasked with conducting an impartial and independent peer review in accordance with the Statement of Work (SoW; Appendix 2) and Review Workshop (RW) Tentative Terms of Reference (ToRs; Annex 2 of Appendix 2). The overall goal of the review was to evaluate whether the design, protocols, and analytical methods developed for the NWFSC's hook and line survey are suitable for achieving the survey's objectives. The specific goals of the review meeting were to: (i) evaluate the hook and line survey's design and protocols; (ii) examine the analytical methods used to generate abundance indices; and (iii) provide suggestions regarding potential expansion of the survey's geographic range and species for which abundance indices are generated, particularly for data-poor and data-limited species.

The tentative agenda of the panel review meeting is attached as Annex 3 of Appendix 2. The Review Panel (RP) consisted of a Chair and two CIE reviewers. The CIE reviewers were independent and had working knowledge and recent experience in the application of fish population dynamics, stock assessment methods, and fishery survey design.

2. Role of reviewer

I attended the NWFSC Southern California Shelf Rockfish Hook and Line Survey meeting in Seattle, Washington, on 4 and 5 April 2012. I reviewed the presentations and reports and participated in discussion of these documents, in accord with the SoW and ToRs (see Appendix 2). During the meeting, clarification was sought on the ToRs because they were very general and the panel unanimously felt that the general answers that they could supply given the available information might not be as useful to the survey team / PFCM as responses to more species- or topic-specific questions. In such instances, the clarifications have been added to the ToRs. This report is structured according to my interpretation of the required format and content described in Annex 1 of Appendix 2.

I reviewed the background documents provided. These are listed in Appendix 1.

3. Findings

ToR 1: The overall goal of this review is to evaluate whether the design, protocols, and analytical methods developed for the NWFSC's hook and line survey are suitable for achieving the survey's objectives. The survey's primary objective is to generate information for use in stock assessments of structure-associated rockfish, particularly those species (<u>read:</u> bocaccio, vermillion complex and greenspotted rockfish) ***which are poorly sampled by trawl gear used in coast-wide surveys. Such information includes fishery-independent indices of abundance as well as biological data on size, age and maturity.***

<u>Panel conclusions</u>

The term of reference summarises the more detailed information on discussed in the other terms of reference. These are thus not addressed again here, but a suitable response is given under the executive summary with additional information found in the conclusions and recommendations section.

ToR 2: Review recent literature (to be provided as background materials) to become familiar with the key species and the primary science and management issues within the Pacific Fishery Management Council (PFMC) umbrella for groundfish in general and structure-associated shelf rockfish in particular.

<u>Panel conclusions:</u>

The background material supplied for the review gave a general overview of the groundfish stocks under the PFMC. Most of the material consisted of stock assessments for various species of rockfish which, like the assessments for bocaccio and vermillion rockfish, were either sparse or lacking in fishery- independent information for the exploited ages. Given the substantial impact of management measures in recent years on the take of rockfish on the Pacific coast, such fishery- independent information is almost certainly necessary in order to obtain unbiased results of management parameters for these and other less commonly taken species.

Although it is possible to identify the hook and line survey as an important potential contributor in providing fishery- independent information to rockfish stock assessments, especially those of structure orientated species that are poorly sampled by other means, it is not possible to ascertain how the information will interact with the other available sources of data in the individual assessments (beyond those that have already been examined, such as bocaccio and vermillion rockfish). Given that neither potential indices of abundance from the survey for species other than bocaccio and vermillion rockfish were presented to the panel and that insufficient information was made available on the assessments, no assessment of the suitability of the survey information other than the general need for fishery- independent information can be made for species beyond the two major ones.

Additional reviewer views

Although an assessment report should and generally does provide a great deal of ancillary information, such a document cannot replace the detailed knowledge gained from years of expertise working with a particular stock. It is the latter type of experience that will ultimately best be used to adjudicate on the utility of the survey for the assessment of specific species / stocks. Consequently, the question as to whether the hook and line index is of value to a particular assessment is best answered by those conducting the assessments, and comments on general principles made by external reviewers to the stock assessment should not be relied upon solely in terms of making recommendations with respect to the specifics of an assessment that they are not reviewing in full.

ToR 3: Evaluate the suitability of the survey sampling design. Specifically, is the design appropriate for generating abundance indices for shelf rockfish species (read: bocaccio, vermillion complex and greenspotted rockfish)***? Comment on the benefits and drawbacks of the current fixed-site design. Are there benefits to replace or modify the survey's existing fixed-site design with one that includes a random component? If so, do the benefits outweigh the drawbacks associated with disrupting the continuity of the survey's current 8-year time series?***

Panel conclusions

Evaluation of the sampling design's suitability is difficult in isolation of the method used to derive the index information. The latter is discussed in more detail in ToR 6, whereas here the focus is more on the basic principles implemented in the survey design.

The initial attempt by the NWFSC was to develop a random survey design based on a sampling universe defined by the presence of structure-orientated rockfish. The areas containing rockfish habitat were defined in conjunction with the commercial and sportfish industry. Examination of the bathymetry of the southern California Bight overlaid with sampling sites indicates that the areas of the sites thought to be representative (sites are points) covers a large portion of the rocky habitat within the depth range appropriate for the species under examination. However, after the initial trial of the survey in 2003, it became apparent that the areas were less homogenous (many ¼-mile square stations contained no structure, although they were clearly adjacent to areas that did) than could be sampled effectively by a stratified random design survey given the level of available resources / time. The sampling design rapidly evolved to a fixed station sampling design with 121 unique stations identified by a 100 m circle around a point position.

Both fixed station and stratified random sampling designs have advantages and disadvantages dependent on a number of characteristics of the population for which the samples are to be representative. The drawbacks of the stratified random design have already been alluded to in reference to the initial survey development. The sampling efforts required to derive stable indices of abundance for a stratum / area were in excess of what could practically be done given the substantial coverage required of the survey.

The fixed station design can at best provide a representation of the relative trends in abundance and therefore requires estimation of survey catchability (an additional scaling parameter) in the assessment. In practice, however, catchability is usually confounded with gear selectivity so that frequently there is little difference in terms of parsimony. In this case in particular, where the effective area covered by the gangion is complex to ascertain, one has to assume that even a random design would have to be treated as a relative index.

Separating the effort among a SRS component and a fixed station component, rather than bringing out the best of both worlds, seems in practice merely to result in the worst of both worlds and rarely can the indices be used effectively.

Additional reviewer views

Fixed station vs. random design

I have dealt with a number of instances where an attempt was made to transition from one type of design to another, usually from the fixed to the random design. Invariably, the linkages between the indices derived from the design are tenuous and inappropriate. Fundamentally, there is little difference in the type of data derived from each index, and the results should be the same if there is no spatial shift in the distribution and little variability in the catches between stations either in terms of the central tendency or the variance estimate. In reality there is usually some shift in the distribution often attributable to temporal changes in the environmental conditions and some persistent differences in the abundance at a site as a result of spatial differences in the environmental conditions (habitat quality). The most advantageous survey design in a specific situation can be determined by the relative size of the spatial vs. the temporal changes in distribution.

From a statistical perspective, it is not easy to determine the size of the effect caused by temporal changes in distribution unless the relationship between environment and abundance has been defined independently, as they might be during a random stratified survey. Essentially then a fixed station design is susceptible to bias and a random design is susceptible to variation. It is not possible to statistically determine degree of bias from the data unlike variance, which can always be calculated provided there are two or more samples. This is the exact reason why in the situation where both types of data exist, or a transition from one type of survey design to another is called for, the only consistent index that can be provided is one based on the random component and where fixed station data are usually ignored.

A permanent small random component can at best be used to determine qualitatively whether there are likely systematic large-scale changes in the distribution over time, indicating a possible bias in the fixed station index. The effectiveness of this depends on the scale of the changes and the periodicity with which they arise, because such changes will require there to be sufficient samples representative of the ‘new’ conditions, to overcome the additional variance component. No further information on the random component taken from 2004 to 2006 was provided in this review, but presumably if it was evaluated at all, it was impossible to highlight any significant sources of bias. Other reasons cited in the presentation were the strategic exploitation of sites by the fishing industry, i.e. not to use survey sites prior to the survey, and to guard against survey-generated depletion. If the extent of population mixing and the size of the local populations were sufficiently small that these effects would become apparent in the survey data, then there would be much greater concerns regarding the assessment assumptions about mixed populations, and catchability constraints should be obvious from assessment diagnostics.

Interestingly, the results from most fixed station design surveys are usually not corrected for sites, because the assumption is that each site is representative of a certain portion of the population. Here, because not all sites were sampled in all years, a GLM assuming orthogonal behaviour between sites and year is used. If this assumption is appropriate, then the abundance could equally be assessed at a single fixed station (with known sampling variability or a small number of replicates to assess the latter). In part, this apparent paradox is caused by the need to account for the development of the sampling design to its current level of 121 stations, a significant proportion of which were not sampled in the early years and a small proportion of which may not be sampled in a specific year through adverse weather or logistic considerations.

To my knowledge there are no plans to return to a random design, so there appears to be no justification to move to a part fixed, part random design, the cost of which would almost certainly be a decrease in the number of stations consistently sampled throughout the time-series. The use of the orthogonal assumption between sites and year in the index calculation is problematic (see response to ToR 6), and although it is possible to justify its use in instances where some samples may be missing in individual years, it can scarcely be defended as a means of providing a random component to the survey for which it appears there is currently little use.

ToR 4: Evaluate the appropriateness of the gear used during the hook and line survey: rod and reel, mainline, gangion specifications, terminal tackle specifications, etc.

Panel conclusions

In general, the development of the survey gear and protocol has been laudably conducted in consultation and cooperation with the main users of the resource, both commercial and recreational charterboats. The cooperation with industry appears not only to have been a success in terms of survey development, but also in terms of stakeholder involvement and exchange of ideas between scientists and fishers. That said, there appeared to be little that reviewers could add to the understanding /improvement of the gear set-up, but an attempt was made to examine critically the capture process to understand better the likely relationship between the proposed index measure (probability of capturing a fish on a hook) and real abundance. The following points were discussed in detail:

1) It is certain that the essentially binomial probability of catching a fish on a hook or not cannot be linked linearly to abundance. A linear approximation may be appropriate over a

limited range of abundance, but the range over which such an assumption may be appropriate not only depends on the range of abundances encountered, but also on where the range is observed in relation to the unknown inflection point. Because of the differences in abundance of the different species and the difference in the extent of clustering at specific stations, it is not possible to make generalizations across species and areas with respect to the suitability of the index.

2) The processes involved in catching a fish are:
    a. Probability of encountering a fish of the desired species depends on density, drift speed, drop duration, water clarity / light (environmental conditions) and hook position
    b. Probability of striking given encounter depends on 'hunger' (environmental conditions), bait / hook availability (inverse to density), effect of previous disturbance (drop number)
    c. Probability of capture given a strike depends on interference from other fish (density), strike angle (hook position)
    d. Probability of retention given capture depends on period between capture and retrieval (drop duration-first strike), number of occupied hooks (density)

    Because the same variables affect the different processes at different rates and in different directions, it is unlikely that the probability of catching a fish of a specific species on a hook can be considered to be a strict sigmoid relationship. Although likely monotonic, the relationship may not necessarily be sigmoid, which could potentially be problematic especially for rare species when factors such as changes in the abundance of other species may mask trends.

3) The error structure of the binomial index appears to be simple, in the sense that the result can take only one of two outcomes, with the average probability located between the extremes. However, given the underlying complexity, it is almost certain that the error structure will have some degree of asymmetry/overdispersal compared with the expected error distribution, leading to overcomplicated models when using binomial likelihood-based model selection criteria (AIC, BIC, etc.) in the development of GLM-based index models, as applied in section 6).

4) Almost all the subprocesses (under point 2) are dependent on abundance in some way. As indicated, this will affect the shape of the response curve, but more concerning is the fact that the abundance of other species will affect many of the density-dependent processes, so the index is likely to be sensitive to changes in the abundance of cogeners. If management measures were to affect the ratio of the species (systematic bias), this would lead to biases in the estimation of abundance, which could only be compensated for by including the total abundance at a site as a covariate in the GLM. Sensibly, because of the lack of independence, total abundance has not been included in the models for the

abundant bocaccio and vermillion rockfish, and in any case the effect is likely to have been small prior to 2011. Recent estimates, however, suggest that there may well have been a change in the relative abundance of species and that total abundance has been increasing potentially limiting the use of the index particularly for rarer species and those that have not been increasing.

5) If differences in abundance were the result of random effects, i.e. different ratios of species at different sites (despite an overall constant species ratio) the effect would lead to further overdispersal of the error structure. In other words, the central tendency would remain the same, but the variance would be greater than expected. In such a case, use of the total rockfish catch as a scalar in the variance term may provide one way of more appropriately modelling the error structure in the data.

Additional reviewer views

Gear saturation

If abundances were to increase in rockfish, gear saturation may become a serious concern despite the large number of hooks deployed at a site. If as suggested at the review, the survey is intended only as a proxy of abundance while the stocks are at low abundance and consequently little fishery-dependent information is available, this may not present a problem; but if the survey data are intended to provide an accurate indication of the rate of recovery of the stock, then gear saturation needs to be considered carefully, including the spatial response of the species to increases in abundance. Are fish increasing because more sites are occupied, or because the same sites are occupied in greater abundance? How does this relate to the sampling universe? Without a better understanding of these effects, the utility of the survey may essentially be limited to determining the direction of a trend, and possibly qualitatively if there is some recovery, but the survey would struggle to determining the rate of any recovery or further decline accurately.

Currently, five hooks are deployed on a gangion from three positions on the boat, with five drops per site suggesting 75 unequal replicates at each of the 102 sites. Although it is rare for all hooks to be taken at a single station, it may be too early to say that this implies that gear saturation is not an issue in the survey. Gear saturation may be an issue for individual species, e.g. greenspotted rockfish tend to be found nearer the bottom and tend to take hooks farther up the gangion less frequently. Because not all the hooks are 'equal,' gear saturation may be occurring well before all hooks are filled. Similarly, it is known that hook rates decline in response to repeated disturbance by fishing activity. The covariable 'drop' attempts to account for this effect in the GLM model (ToR 6), but this only works if the disturbance is non-infectious, i.e. if the decline in feeding activity is linearly related to abundance. If feeding ceases in the whole aggregation irrespective of the size of the aggregation, then abundance will be underestimated. In both cases, the behaviour may lead to empty hooks despite some gear-saturation effects, although the latter response is obviously more problematic for the index.

Necessary additional complexity owing to bait loss?

The gear is baited, and frequently a hook may be returned without bait. The assumption appears to be that a fish (of unknown species and size) has removed the bait from the hook without being caught or perhaps that it has escaped after capture. Currently the analysis treats those hooks identically to those that retained their bait. Realistically, though, there is a difference, because without bait there is a reduction in the attractiveness of the hook, but with residual attraction provided by the shrimp fly attachment. This extra stage of the capture process after the loss of bait at an unknown time presents an additional undesirable level of complexity. One may argue that the probability of bait loss and the probability of capturing a fish on an empty hook are proportional to abundance, suggesting that the link between probability of capture and abundance is even more complex than the expected sigmoid curve.

An interesting comparison would be to determine the difference in attraction of baited and unbaited hooks. If sufficient fish could be captured with bare hooks and the effect of the bait could be determined reliably, then it would be worth considering whether at high-density sites, where bait loss would tend to have it greatest effect and where gear saturation in general might be problematic, the use of bare hooks might be a viable alternative.

ToR 5: Evaluate the fishing and biological sampling protocols used during the hook and line survey.

Panel conclusions

By virtue of the rigorous sampling protocol followed, most of the variance-increasing components are well controlled but still allow for practical implementation. Site for example could be judged as a single set of coordinates. However, fish behaviour is such that the exact location of the aggregations over the structure is variable and a single set of coordinates would tend to measure different proportions of the aggregation. Skippers use acoustics to locate the aggregations within the 100 m radius of the single point position before deploying the gear. The latter process may well lead to skipper/boat effects attributable to differences in the acoustic equipment and acoustic interpretation and boat behaviour during the drop. The exact nature of these effects are unlikely to be understood, but are accounted for in the design. A number of such design/factor variables are recorded for use in the later modelling process to reduce variation in the estimate attributable to such issues as hook, drop, angler position, and site.

A number of continuous variables are also recorded at the level of drop and site, e.g. drift speed and drop duration, and environmental conditions. The aim in documenting this information is to ensure that differences in the conditions that affect catchability can be accounted for in the GLM models so that the abundance trends are isolated more effectively. For most variables, though, there seemed to be little systematic change over the period of the survey, exceptions of concern from a survey design perspective being the time to the first bite and the duration of the drop, both of which appeared to be lower in 2004 than in other years (Figure 1). Wave height and mean vessel drift speed tended to be lower in 2011. If these effects on catchability can be effectively disentangled from the year effect in the GLM, then the index should be robust. Further discussions on potential dangers of this approach and possible methods for analytical improvements are discussed under ToR 6.

The survey is therefore well designed in terms of its procedures, with most variables strictly

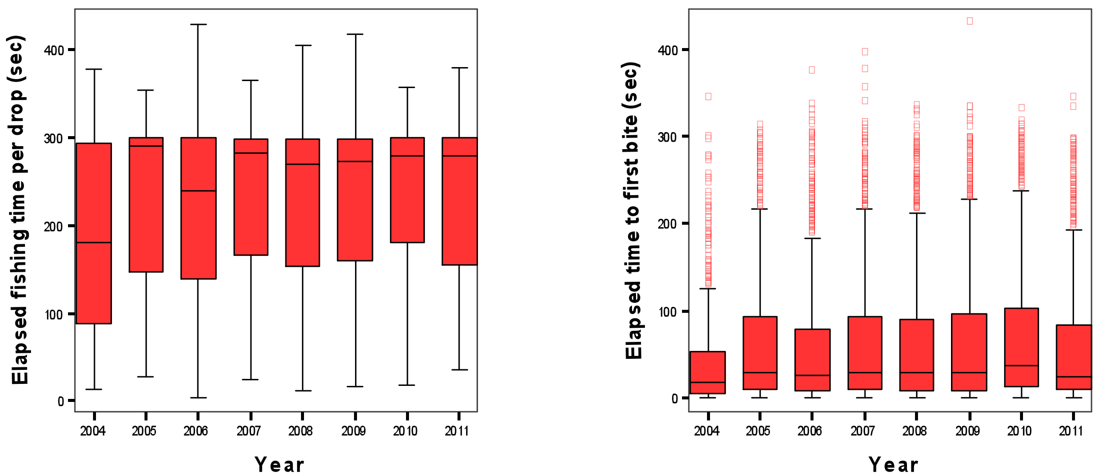

Figure 1 Summary of the covariables ‘drop time’ (left) and ‘time to first bite’(right) suggesting that both may have been shorter in 2004 than in other years.

controlled through standardization, and other variables, especially those important in the use of passive gears considered as much as possible, which should make the data as robust as possible to the influence of variables over which there is little or no control.

Additional reviewer views

The presentation of the biological sampling protocols and QAQC procedures invoked relatively little discussion from the panel. Significant additional information is collected, including fin clips for genetic analysis and maturity data. Although this is important information for population identification and determining other stock assessment parameters specific to particular assessments, little can be said with respect to their general utility without further analysis being presented. Given the relatively small additional effort involved in taking biological samples compared with the effort involved in obtaining the catches, the opportunity to collect this ancillary information should continue to be exploited wherever possible.

One notable exception is the age information. It appears that otoliths are collected routinely from survey catches, but these data appear not to be used directly in the assessment process, instead relying on general growth curves to interpret the length frequency information from the survey. Length frequency information from the survey was presented for bocaccio and vermillion rockfish, and it was suggested that the survey was able to track cohorts in the length frequency data. Although I do not disagree with the assertion, such visual interpretation is subjective, especially where, as in these species, there seems to be substantial overlap in the lengths at age within a year and some variability between years. A more convincing argument could be made if this information could be corroborated by the age information. Survey information would likely also carry more weight in an assessment dominated by fishery-dependent data if such data were to contain age information also. Effort needs to be made to evaluate this critical information, because the question could be asked why else it is being collected.

ToR 6: Evaluate the methods and assumptions used to analyse the survey data as well as the associated uncertainty of the abundance estimates.

Panel conclusions

By far the largest part of the review meeting discussions centred on the analysis of the data for the purposes of developing standardized index information. Most of these discussions focused on the bocaccio index, which had been presented previously and used in the most recent stock assessment. Although on the final day an experimental assessment was shown for the greenspotted rockfish, almost all conclusions and analysis were based on the example of the bocaccio index. The use of GLM models in standardizing abundance information is common practice, but what is unusual about this index is merely its binomial nature, the extensive habitat specificity and hence clumped distribution of the species, and the passive method of sampling relying almost entirely on the consistency of fish behaviour to provide a robust index. For clarity, the discussions are grouped into four topic areas in this section.

Use of a binomial index as representative of the abundance:

The bocaccio assessment constructed in stock synthesis (SS3) currently assumes a linear relationship between the index and stock abundance for the selected cohorts in the survey. Given that the index is binomial, it is almost certain that this assumed functional form will not hold over greater ranges of abundance, let alone the entire range of possible stock biomass. The argument that bocaccio abundance had not changed dramatically until 2011 and therefore that this will not have an effect on the assessment seems futile, now that abundance appears to have increased substantially. In any case it is not possible to determine the range of stock sizes over which a linear assumption may be acceptable, because this depends not only on the range, but also on the absolute level. Consequently, if the aim is to continue modelling the survey index as a binomial index describing the probability of catching a bocaccio on a specific hook, then the index will have to be modelled more realistically in the assessment. This does not seem overly complicated in SS3, and should be done.

Currently, the probability of catching a fish on a specific hook is about 35%, so the argument could be made that this leaves a significant number of hooks available for further increases in abundance to be detectable through further increases in the probability of catching a fish. Effective rates of occupancy of hooks for some species may be much higher, e.g. greenspotted rockfish tend to be found preferably on hooks nearer the clump and hooks farther away may not be taken, so no further fish may be caught despite hooks still being available. Similarly, some 10% of sites exhibit 80–100% hook occupancy, so presumably these are prime habitat sites (Figure 2), and if the population increases on these sites, then little or no increase in the index will be noted with increases in overall abundance. Such hyperstability is undesirable.

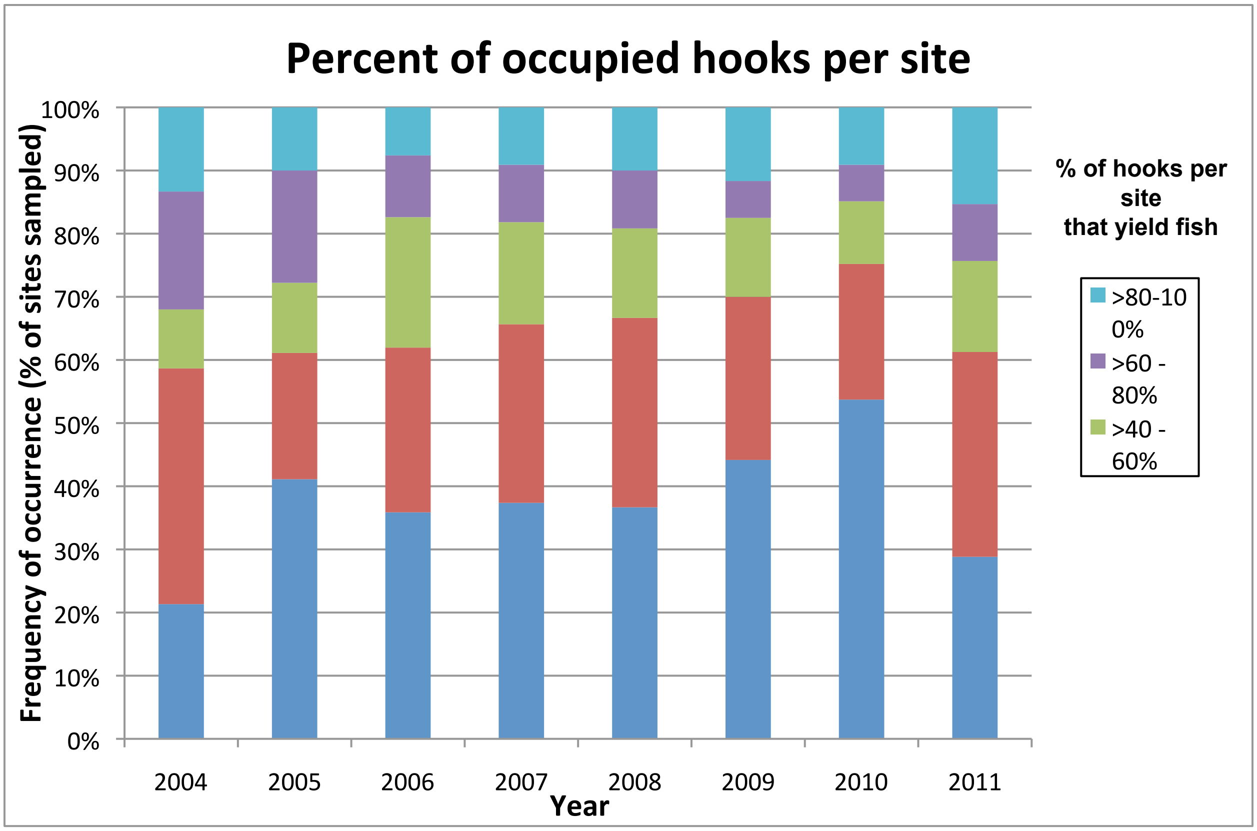

Figure 2: Percent hook occupancy by site

<u>Model complexity and error structure</u>

Optimal model complexity for binomial GLM models was discussed because there are some advantages and disadvantages of having highly complex models relative to simple ones. The model-building approach was to include the year effect necessary for index output and the design variables (boat, site, drop, position and hook) in the model irrespective of whether or not they proved significant. Additional continuous covariables, not under the control of the survey yet thought to affect catchability and in some instances the squared terms of the same variables to account for nonlinear effects, were also included in a stepwise procedure based on the Bayesian information criterion (BIC).

It seems counter-intuitive to include all design variables in the index whether or not they are significant. Certainly, year is necessary, site is sensible, because of the change in the sites sampled, but whether it is useful to include angler position, hook number (which may be important for ground-associated species) and boat, when in almost all cases both boats, all three angler positions, and five hooks were used seems questionable, especially as it is difficult to understand the process by which some of these effects could be operating. Investigations using the bocaccio rockfish model indicated that certainly for the angler position, the results within a year were unstable.

The model constructed for each year's data separately implied different ordering of the angler position data in each year and that the parameter estimation will likely be unstable over time. If there is reason to assume that the effect of angler position differs between years, in which case an interactive term with year should be chosen, it is likely that the model is interpreting random variation as an effect because of the differences between the assumed and the real error structures. In the latter case, the resultant model would underestimate the uncertainty in the estimates. In those cases, it would seem appropriate to remove the variable from the analysis to reflect the greater uncertainty until the potential effect is better understood if the confidence intervals as well as the estimates are to be used in the assessment.

Another potential problem is the correlation between independent variables. An example that was discussed at length at the meeting was the variable drop time. The intent is to correct the year effect for potential differences in effort between years. Including this variable in the model suggests that longer drop times result in lower catches. This may at first appear to be counter-intuitive, but discussions with the skippers suggested that longer drop times were generally correlated with sites where few fish were observed on the sounders. By inference then, if fewer fish were observed at more sites during a year, this affect would be more frequent. Consequently, the model would attribute some of the decrease in abundance from the year effect to this variable, and the decline in the population would be underestimated. Taking this to the extreme, in a year where very few fish were present, drop times would be very long (they are sensibly constrained in the survey design, but the principle still applies) and the lack of catches would be attributed to the long drop times, not to a decline in the population.

GLMs in R share variance components equally between the correlated components of the independent variables because of interactive reweighting. Other methods of fitting models sequentially are available in different packages and can attribute the shared component to one variable, but this does not correctly distinguish between the causal components either and will tend to reduce the confidence limits artificially without understanding the mechanism of the actual effects. Simpler models will be as susceptible to biases in the index as more complex ones, but the latter at least tend to compensate for this by having larger confidence intervals, which if used in the assessment process will more accurately describe the uncertainty.

Additional reviewer views

Current model selection includes second order polynomials of continuous variables. Second order terms in general are used to model nonlinearity effects. If nonlinear terms are sought, it is not clear to me that second order polynomials are sufficient to describe the complex capture process. Before using such terms, there would be value in investigating the effects using spline functions to examine the realism of these apparent effects. In addition, interactive terms for continuous variables are very difficult to interpret and would require extensive independent analysis with respect to their statistical suitability, as well as to the realism of the effect.

As a general comment, a number of cyclic continuous variables such as state of tide and moon phase have been modelled as discrete variables. Some attempts could be made to investigate if these variables would not be better modelled using periodic splines, although at least superficially these variables seem to have little or no effect on the catch rates of bocaccio, but may be more appropriate for other species.

In general I would tend towards an approach for model selection focused less on the statistical properties and more on understanding the processes involved. In the case of covariance between independent variables, I would tend to err on the side of caution, especially for variables that correlate with the year effect. I suspect that, given that our understanding of this type of survey data is still in its infancy, this will result in significant simplification of the models relative to those used in the assessment, with a resultant, in my opinion appropriate, increase in the estimate of uncertainty.

Spatial issues and model parsimony

Panel conclusions

The GLM currently used for bocaccio uses a site effect mainly because not all sites could be sampled in all years. The effect is independent of the year effect (no interaction), so assumes that the population is equally distributed among sites each year. However, given that at least for bocaccio there appear to be ontogenetic movements from shallower to deeper sites, such orthogonality may not be appropriate when the ratio of juveniles to adults changes in the population. As an example, a recruitment spike may raise the number of fish caught on the inshore stations only. If it were not possible to sample the offshore stations, the GLM would then extrapolate the increase to the offshore areas, implying that the adult population had also increased by an equivalent amount. If the latter stations were sampled, abundances would be averaged between stations (overestimating offshore abundance and underestimating inshore abundance). Unless inshore and offshore stations were sampled exactly in proportion to the overall availability of the fish, the length frequency information would be inconsistent with the index information.

One solution to the problem would be to include an interactive term in the model, but this would greatly increase the number of parameters to estimate and likely underestimate the uncertainty if the sampling error structure is overdispersed. One solution would be to stratify the stations into areas and to estimate interactive terms by area to account for the ontogenetic shifts in distribution. Certainly, the flypaper plot for bocaccio suggests that there are spatial consistencies in the data at a scale significantly larger than site. In fact it appears that variation between areas is significantly larger than sample variation and that the variation between years is consistent across sites, so that an interactive term is necessary (Figure 3).

Almost certainly some form of stratification (area effect) is necessary, which raises two questions. First, which sites should be allocated to what number of strata, and second, which weight should be ascribed to each stratum in terms of the proportion? The development of such strata and their weighting can take many forms which were not discussed in detail at the meeting, and the most appropriate methodology may well be species- and data-dependent. Having only had a cursory glance at the available information, an approach is outlined under additional reviewer views below, but this approach may not necessarily work to full satisfaction in this case, so should be viewed merely as a starting point.

Additional reviewer views

Defining areas seems a relatively simple problem to carry out by eye with roughly five strata, but a less subjective approach would be to cluster samples (using the length frequency distributions by sample matrix). If samples from stations cluster automatically, i.e. the station effect is larger than the year effect, then only determination of the appropriate number of strata remains. This would almost certainly be subjective, but too many strata will reduce parsimony and too few will increase variance in the estimate. A further consideration is that at least one sample is required in each stratum in each year, which given the changes in sampling design, will greatly limit the options. Another consideration is the evenness of the number of stations in each stratum, with an unbalanced design with a small number of large strata with many stations and a large number of strata with one or two stations suggestive of too high a level of stratification.

More likely than not, though, the clustering may arise more efficiently by year, i.e. samples from a year being more similar than samples from a station. In this case it would be necessary to remove the effect of year by combining all length frequencies from a single station into a single sample. This may result in other undesirable effects, though. Instead, examining in n-dimensional space may be more appropriate. Partial canonical coordination analysis using only the covariate year would remove the effect of year. The plot of the first two unconstrained axes from the analysis should provide sufficient information to examine the separation of sites. Plotting of the species (here the length frequencies) will give indications of which lengths co-occur and may be indicative of ontogenetic shifts or spatial patterns of recruitment caused by large-scale environmental conditions. Clusters of stations can be determined using for example the Euclidian distance measure in n-dimensional space. It is unlikely that clusters grown in this way will occasionally span across years, i.e. a sample from one station may occur in more than one cluster. The number of these jumps can be used as a criterion for selecting the appropriate level of clustering, but inevitably some subjectivity will be required to assign a station to a single stratum.

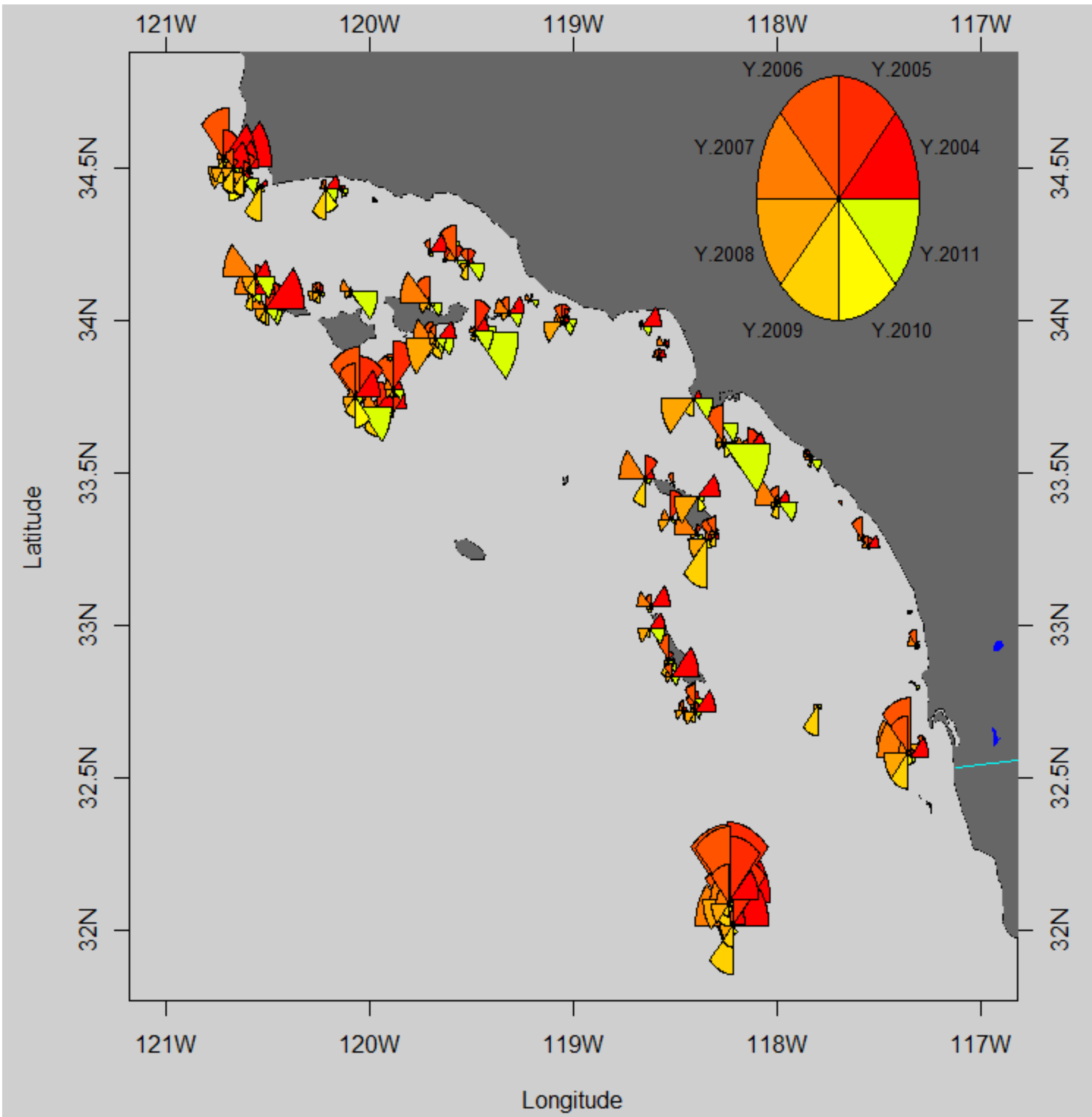

Figure 3 Flypaper plot showing the development of the index over time. The radius of each slice is equivalent to the catch in each year starting with 2004 at 3 o'clock and moving counter clockwise to 2011 illustrating that the increase in the index in 2011 is largely due to the increases in the catches in the central area, while catches in the southern portion have declined markedly since 2009 (Not all stations were sampled in all years, particularly 2004-2006, but also the

southern most stations were not sampled in 2011 which appears more obvious because of the historically high catches in the area).

More complex is the determination of the appropriate weighting of each stratum in the determination of the index. An area-based approach would be an appropriate first approximation. The original sampling design determined discrete areas in which samples were to be taken randomly according to the area of each stratum (assuming that stations within an area more or less conform to the clusters) and could be used in the weighting, especially because the sites were selected in a systematic manner to cover the whole of the available habitat evenly. However, some areas apparently contain more effective habitat (outcrops) than others, so additional weighting should be considered once the effective habitat has been described more accurately. Also, some strata may extend over substantial areas but overall contain only a small portion of the population (few fish at each site); changes in the abundance there may overemphasize changes in the abundance of the stock overall, so this issue should be considered once effective habitat has been determined. Any weighting used in the calculation should also be applied to the length and age information, where applicable.

<u>Use of the MCMC approach to determine statistical power:</u>

<u>Panel conclusions</u>

The MCMC approach to determining the uncertainty and power of the index appears to be statistically sound and useful, but the additional considerations below may provide some additional considerations for future examination.

- The error structure in the data is binomial and the effects are real/stable. This appears not to be the case, or at least the process is significantly more complicated than a simple binomial process, and parameter estimation appears at least to be not yet stable, with additional years providing new estimates. As a consequence, analysis likely overestimates the power of the test by a small amount, although this should decrease because the model is able to assess the variance and effects component better given additional data.
- The development of a power test is not fully understood. Clearly, the use of the index is to examine trends over time, which would have significantly more power than the examination of the change from one year to the next if the dynamics are represented appropriately. Further, the determination of a significant increase in abundance from one year to the next from the index is potentially irreconcilable with an assessment that because of its additional data sources determines that there was no such increase. What would managers do in such an instance? Should they ignore the assessment in favour of the index?

Additional reviewer views

- The analysis is only applicable to the current state of the stock/index. At higher or lower abundances, the potential change in the stock size which could be determined statistically is different because of the nonlinear nature of the index. The facultative asymmetry of the confidence limits (uncertainty) attributable to the bounded results (catch or no catch on a hook) implies that it will be difficult to use the uncertainty of the index in the formal assessment process. However, use in the assessment of the linear predictor on a logit scale rather than the back-transformed results may provide a suitable remedy to a number of issues with the nonlinearity assumption and the need to back-transform data. However special consideration would need to be given to the deviance contribution of the index in SS3.
- A more formal analysis of the multinomial properties of catch (i.e. the total catch by station) and its uncertainty was proposed. This is an interesting endeavour scientifically to provide an insight as to the likely behaviour/properties of such an index. I do feel, however, that because this does not consider the full complexity of the process involved in capturing an individual, it might not greatly further the derivation of uncertainty estimates in the process.

ToR 7: Evaluate the utility of hook and line survey data for species encountered consistently at a subset of sites, but for which the survey's coverage may be near the margins of their range (e.g., copper rockfish, widow rockfish, yellowtail rockfish) and other species we encounter episodically in each survey year (e.g, chilipepper). Identify modifications to the survey's design, protocols, or analyses which may improve the utility of survey data for stock assessments of additional species (read: without compromising the survey's primary objectives)**.**

Panel conclusions

Generally speaking, if the survey is indicative of only a small part of the population as suggested by the ToR for copper, widow and yellowtail rockfish, then there are significant dangers with respect to their use as indices of abundance, no matter how compelling the need for information on these species. If it could be proved that population mixing with the portions of the population not covered by the survey is sufficient for the surveyed component to be representative of the population as a whole, then significant benefit could be derived from assessments of these species. However, for many rockfish species, movements would appear to be more restrictive than this assumption.

The current survey design and effort provides useful numbers of the main three rockfish species (bocaccio, vermillion and greenspotted rockfish). Other species make up only a minor component of the catches taken, so additional information beyond the abundance index such as cohort strength, growth and maturity information is unlikely to be of great benefit to the assessment process for such species unless sample numbers can be increased. One method of doing so would be to increase the number of drops made in the areas where species like copper, widow and yellowtail rockfish are found. It would be more difficult to do this for the episodically encountered chilipepper rockfish as its appearance is more unpredictable and would require adaptive sampling to improve numbers. As in all cases though, high intensity sampling over a small spatial scale, especially if it is at the edges of the population, does carry with it the danger that the samples may not be independent.

Additional reviewer views

Frequently, the use of differential growth in different parts of a species range is considered to be an indication of a discontinuity of a population. Although genetic differences would imply strong separation of populations, suggesting separate assessments should be conducted, environmental differences can also account for variation in growth and suggest some restriction to the complete mixing of the population at the adult level only. At the time of recruitment, the contributions from the latter subpopulations may well represent a single pool, at which point an understanding of how the differences in growth over the range of the population can affect selectivity becomes important. Increasing the number of biological samples taken for these rarer species by increasing the number of drops conducted where these species persist would appear to be an effective measure of increasing our understanding of growth in these populations.

ToR 8: Potential survey expansion and other possible enhancements or modifications to the survey which could lead to additional objectives

Panel conclusions

The panel found it very difficult to address this ToR beyond the generalities. Generating more data at little or no additional cost appears to be worthwhile, but given the issue of stratification and weighting, additional habitat information at the sampling sites should be collected as well as data on the likely number of aggregations in an area that is not part of the sampling universe. It may well be possible to examine the latter using acoustic transect information collected *ad hoc* during surveys if the routes between sampling sites could cover areas effectively, or night-time acoustic grid work could help define weight more effectively. Additional environmental information, especially with respect to spatial difference in the environmental conditions and the effects this might have on the distribution of rockfish is useful, especially in light of the consideration of the changing current conditions in the area south of Pt Conception.

Additional reviewer views

- *Does the current design lend itself to expansion?*

  This is highly dependent on the areas and species considered. Judging by the fact that the origins of this survey were claims that the depletion in the SCB were smaller than those found north of Pt Conception (PtC), if true it would suggest that catches in the latter area for example would be lower. Bocaccio at least according to the stock assessment being at quite low levels of biomass and hence in terms of a binomial index almost certainly on the slowly ascending limb of the sigmoid curve would imply that adding samples from a low-density area would yield little additional power to the analysis in terms of detecting changes in abundance either up or down for this particular species.

Species that have their population centre north of PtC would clearly benefit, although from the bathymetric information, it would appear that there are many areas north of PtC that may be sampled adequately by conventional groundfish surveys, although admittedly the precise amount of hard structure is not immediately apparent from the bathymetry.

Another concern in terms of expansion is the environmental conditions over which sampling using the gear is suitable. For example, it is apparent from discussions at the meeting that the ability of the hook and line gear to function effectively is not unlimited. Sites are selected based on maximum depth. Although it is now apparent that the gear may be suitable slightly deeper than currently employed, the technique certainly cannot stretch to cover the full range of depths covered by all rockfish species.

- *Evaluate whether expanding the survey's sampling area would yield information useful for the assessment of structure associated rockfish*
- *What are the scientific benefits and drawbacks of expanding the survey into adjacent areas currently not included in the survey area such as north of Pt Conception or into the Cowcod Conservation Areas?*

The origins of the survey are closely linked with claims that there was a differential decline in bocaccio rockfish abundance in the northern relative to the southern part of the management area. The survey suggests that the population decline estimated by the bocaccio assessment is steeper than that indicated by the survey since 2004, potentially providing supporting evidence for the claims. However, this discrepancy could simply be the result of a flawed assessment unable to account for the very large reduction in catches caused by severe management measures implemented in recent years. Having an independent measure of the trends in abundance north of PtC would provide useful evidence on the appropriateness of the assessment method.

As far as the Cowcod Conservation Area (CCA) is concerned, this has been excluded from the sampling design, despite the fact that the area historically appears to have been highly productive for bocaccio and there is some anecdotal evidence that the area has served as a source of eggs and recruits to the SCB from larval and juvenile surveys, whereas its effectiveness as a cowcod conservation measure is less well explored. Current exclusion of the survey from the area is based on the fact that the survey may encounter and kill a number of individuals of the greatly diminished population of cowcod. There are emotive issues surrounding the conservation of cowcod, but from a purely logical perspective, if the effect of the CCA is of a size where a hook and line survey of the scale and intensity of that discussed here were to significantly reduce the coastwide cowcod population size, then the conservation value of the area is insufficient to warrant maintaining its special status.

Fishery management should always seek to demonstrate the effectiveness of any management measure that is implemented. Only by doing so can it justify its actions/highlight the long-term benefits to the users of the resource. For bocaccio, as for cowcod populations, the CCA represents a significant portion of the available habitat, and dependent on migration rates and egg production it is possible that a significant proportion of the population has been excluded from the assessed stock, rendering the assessments biased and potentially resulting in ineffective management. Without examining the importance of the area to rockfish and monitoring the trends in abundance, we cannot hope to understand fully the population dynamics. The question of whether there are less destructive or more effective techniques available for surveying that area is not known, but if there were, then would it not be equally useful to employ these to monitor the remainder of the rockfish populations consistently?

- *Would the methods used by this survey be effective for collecting data and generating abundance indices for other structure-associated rockfish with high commercial or recreational importance elsewhere along the coast (e.g. yelloweye rockfish off the WA or OR coast)?*

The question of whether to use the method for yelloweye rockfish in WA or OR is partially answered under the general comments on survey expansion in the first paragraph under this section above. In principle, there appears to be little that is fundamentally different about yelloweye compared with bocaccio in the sense that they are structure-orientated. However, the harsher climatic conditions farther north along the US coast may well preclude the effective use of recreational charterboats, or at least significantly reduce the effectiveness. Further consideration needs to be given too to the distribution of habitat. Do habitat maps of locations likely to harbour yelloweye rockfish exist, and can they be defined sufficiently accurately to render effective sampling possible, while also allowing the determination of the proportion of the population that each site/stratum represents? These questions need to be answered first.

4. Summary of conclusions and recommendations

The NWFSC hook and line survey presents a useful approach to get at stock trends for species which are not well represented in other fisheries independent information. How useful this information is to stock assessments is rather more stock specific and can only really be answered for bocaccio and to a lesser degree for vermillion rock fish on the basis of the information presented to this review panel. For other species and other areas significant additional information will need to be presented to make an accurate assessment of the utility of the data, but of course if the conditions apparent for bocaccio hold for other species, there is no reason to assume that the conclusions would be different.

The protocols for obtaining catch and biological information are sufficiently rigorous to show consistent trends in the summarised survey data suggesting the survey is picking up significant information on abundance trends. How this information should be included in the formal assessments process is less clear.

Spatio-temproal trends in the abundance of bocaccio rock fish from the survey suggest that variability mainly occurs at scales larger than the distance between adjacent sites. This information should be presented more formally and either used to derive area based weighting for the calculation of a stratified index (my preferred option) or in the GLMs to provide a more parsimonious model when determining interactions between year and area to account for the spatial shifts in distribution over time.

Use of a standardised index as provided by the GLM and used in the assessment for bocaccio has a number of advantages. It does allow for the correction of some covariables, which either like ‘site’ have not been consistently sampled in the design or environmental conditions affecting the catchability of the gear such as ‘wave’ height. It is however important to try to separate the effects of the independent variables that are causally linked or behaviourally correlated to the abundance. For example the time to retrieval may well be expected to affect total catch as longer soak times provide more opportunity for fish to encounter the gear. However, at sites with high abundance the gear is usually retrieved well before the maximum time to avoid loss of fish from the hooks, so the variable is correlated to catchability as well as abundance, the later of which will be ignored in the index if ‘time to retrieval’ is used as a covariate in the GLM. More generally I think the models should be simplified substantially and the gained parsimony used to efficiently account for spatio-temproal trends which appear to be much more important in understanding the stock dynamics. The small increase in the variance component associated with inter annual differences in the covariables will merely be reflected in a small decrease in the uncertainty of estimates.

A binomial index as developed through the GLM has very different statistical properties from other indices and as such presents some challenges with respect to its use in assessments mainly because of its slightly different implementation than an abundance-based index. At least over wider ranges of stock abundances a linear relationship between abundance and probability of catching a fish is almost certain to be flawed leading to an apparently hyper-stable index. As the stock size changes this consideration needs to be given some serious thought.

In the example presented for bocaccio confidence limits and a power test were provided for the index by way of an MCMC approach. The approach appears to be statistically generally reasonable, but aside of the use of a single year power test for an abundance index designed to describe a timeseries there is a more serious question as to how the confidence limits are used to determine uncertainty. By definition the binomial index must have asymmetric confidence limits at any point away from p=0.5. In the assessment uncertainty is described in the form of a CV which implies symmetry in confidence limits and suggests the hyper-stability in the index when used as a linear model will be further emphasised by way that uncertainty is implemented in the model. Further work needs to be conducted to determine how best to incorporate the binomial index in an assessment including its uncertainty. The use of the linear predictor from the GLM which does show symmetrical error properties could be considered if the penalty function could be adapted to incorporate variance on the logit scale.

Expansion of the survey seems a reasonable approach in principle given that only a fraction of the bocaccio population and almost certainly smaller percentages of other species are surveyed by the current design. While a single index covering the entirety of the populations range is desirable to ward against spatial shifts in relative density, it is not clear if the current survey techniques would be efficient at sampling the wider range due to different conditions and distances involved, and possible differences in local abundance (gear saturation). In contrast, the expansion of the survey into the cowcod conservation area should be given serious consideration from both a management and scientific perspective, while the conditions in the area are much more consistent with the current survey posing fewer challenges for expansion.

Recent trends in abundance since the beginning of the survey do not indicate large changes in the overall relative abundance of the different species. What effect the abundance of one species has on the probability of capturing an individual of another species is ignored in the current index information. For this largely passive gear more work needs to be conducted to account for the abundance of other species if management measures or environmental changes lead to differential development in the trends of different species.

5. Critique of the NMFS review process

This review is a little different from the reviews that I have been involved with previously. Although closely related to the stock assessment process it was examining specifically one methodology of collecting data and how this data is useful to the application of a number of stock assessments. This caused some differences in the expectation of the review process from different members of the group, as well as some uncertainties in the writing of the report. After spending an hour on the second day discussing what could be done for each individual term of reference everyone was on the same page and hopefully the independent reports provide a constructive basis for further improvements in this survey.

Below is a list of issues in relation to the ToRs that could be used to improve the value of future reviews of this kind.

- The first term of reference:" *The overall goal of this review is to evaluate whether the design, protocols, and analytical methods developed for the NWFSC's hook and line survey are suitable for achieving the survey's objectives. The survey's primary objective is to generate information for use in stock assessments of structure-associated rockfish, particularly those species which are poorly sampled by trawl gear used in coast-wide surveys. Such information includes fishery-independent indices of abundance as well as biological data on size, age and maturity.*" This is not really a term of reference, but a summary of the intent of the process so it is very difficult to address as a ToR. In the end I used the executive summary to address this ToR.

- In general the ToR understandably were hoping for an endorsement of the survey as a stock assessment tool. I certainly felt that in many ways these aspirations were justified for bocaccio and possibly vermillion rock fish, but insufficient information was available / presented for other stocks in order for the panel to make the assessment of the utility of the survey. In the end the assessors of the individual stocks are best placed to decide on whether the information is useful or not. Similarly, responses to ToRs relating to the expansion of the survey could only really be based on principals, generalities and commonalities between areas. It is not possible to determine the utility across species and areas. If answers are sought at level of a specific species and a specific area, this needs to be reflected in the ToRs and the necessary information to address the question needs to be presented.

- The last ToR references a 'final panel report', but at the meeting it became apparent that a consensus report could not be requested due to legal issues. Prior clarification of the issue would have helped to avoid the confusion, plus being able to combine the information in a single report may have improved the utility of the review to the survey group, especially since there were no stark differences in opinion amongst the reviewers, just some differences in the prioritization of some issues. We resolved the issue by providing the individual panel reports using a unified format.

Appendix 1: Bibliography of materials provided for review

Dick, E.J., D. Pearson and S. Ralston. 2011. Status of Greenspotted Rockfish, *Sebastes chlorostictus*, in U.S. waters off California**.** Pacific Fishery Management Council Stock Assessment and Fishery Evaluation.

Field, J.C., E.J. Dick, D. Pearson and A.D. MacCall. 2009. Status of bocaccio, *Sebastes paucispinis*, in the Conception, Monterey and Eureka INPFC areas for 2009. Pacific Fishery Management Council Stock Assessment and Fishery Evaluation.

Field, J.C., E.J. Dick, D. Pearson and A.D. MacCall. 2011. Status of bocaccio, *Sebastes paucispinis*, in the Conception, Monterey and Eureka INPFC areas as evaluated for 2011. Pacific Fishery Management Council Stock Assessment and Fishery Evaluation.

Harms, J.H., J.A. Benante, and R.M. Barnhart. 2008. The 2004–2007 hook and line survey of shelf rockfish in the Southern California Bight: Estimates of distribution, abundance, and length composition. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-95, 110 p.

Hyde, J.R., Kimbrell, C.A., Budrick, J.E., Lynn, E.A., Vetter, R.D., 2008. Cryptic speciation in the vermilion rockfish (*Sebastes miniatus*) and the role of bathymetry in the speciation process. Mol. Ecol. 17, 1122–1136.

Harms, J.H., J.R. Wallace, I.J. Stewart. 2010. A fishery-independent estimate of recent population trend for an overfished U.S. West Coast groundfish species, bocaccio rockfish (*Sebastes paucispinis*). Fisheries Research 106: 298-309.

Lea, R.N., R. D. McAllister and D.A. VenTresca. 1999. Biological Aspects of Nearshore Rockfishes of the Genus Sebastes from Central California With Notes On Ecologically Related Sport Fishes. Fish Bulletin 177.

Love, M.S., P. Morris, M. McCrae, and R. Collins. 1990. Life history aspects of 19 rockfish species (*Scorpaenidae: Sebastes*) from the Southern California Bight. NOAA Tech. Rep. NMFS 87, 38 p.

MacCall, A. D. 2002. Status of bocaccio off California in 2002. In: Status of the Pacific Coast Groundfish Fishery Through 2002 Stock Assessment and Fishery Evaluation Vol 1. Pacific Fishery Management Council.

MacCall, A.D. 2005. Assessment of Vermilion Rockfish in Southern and Northern California.

Research and Data Needs 2000-2002. Pacific Fishery Management Council.

Research and Data Needs 2008. Pacific Fishery Management Council.

Sakuma, K. M., S. Ralston, and V. G. Wespestad. 2006. Interannual and spatial variation in young-of-the-year rockfish, *Sebastes spp*.: expanding and coordinating the sampling frame. CalCOFI Reports 47: 127-139.

Stewart, I.J., J.R. Wallace and C. McGilliard. 2009. Status of the U.S. yelloweye rockfish resource in 2009.

Appendix 2: A copy of the CIE Statement of Work

Attachment A: Statement of Work for Dr. Sven Kupschus

External Independent Peer Review by the Center for Independent Experts

NWFSC Southern California Shelf Rockfish Hook and Line Survey

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Technical Representative (COTR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance with the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in Annex 1. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description: The Northwest Fisheries Science Center's (NWFSC) Southern California Shelf Rockfish Hook and Line Survey was designed to collect fishery-independent data for use in the stock assessments of groundfish associated with rocky habitats that are not well-sampled using trawl surveys. Survey data are analyzed to generate annual indices of relative abundance and time series of biological data for several species of shelf rockfish (Genus: Sebastes) including bocaccio (S. paucispinis) – a species declared overfished by the Pacific Fishery Management Council (PFMC) and NOAA Fisheries and designated as a species of concern by NOAA Fisheries.

Hook and line survey data are also used to calculate abundance indices for several other species of shelf rockfish, and in some cases may be the only fishery-independent data available for use in stock assessments for those species. In addition to bocaccio, an abundance index and biological data from this survey have been incorporated into the Southwest Fisheries Science Center (SWFSC) 2011 stock assessment for greenspotted rockfish (S. chlorostictus). Abundance indices have also been calculated for starry rockfish (S. constellatus), speckled rockfish (S. ovalis), vermilion rockfish (S. miniatus) and its recently-delineated cryptic pair, sunset rockfish (S. crocotulus). A stock assessment for vermilion rockfish was conducted by the SWFSC in 2005; however its results were not endorsed by the PFMC's Science and Statistical Committee for use in management in part due to newly-identified evidence of a cryptic species pair within the vermilion rockfish complex. Because this survey collects genetic information from all captured individuals, it is possible to generate separate abundance indices and biological data profiles for both vermilion and sunset rockfish retrospectively from the survey's start in 2004. This information may be helpful for re-visiting the stock assessment process for vermilion rockfish (and/or initiating the process for sunset rockfish.)

The overall goal of this review is to evaluate whether the design, protocols, and analytical methods developed for the NWFSC's hook and line survey are suitable for achieving the survey's objectives. The specific goals of the proposed review meeting are to: 1) evaluate the hook and line survey's design and protocols; 2) examine the analytical methods used to generate abundance indices; and, 3) provide suggestions regarding potential expansion of the survey's geographical range and species for which abundance indices are generated - particularly for data-poor and data-limited species. The Terms of Reference (ToRs) of the peer review are attached in Annex 2. The tentative agenda of the panel review meeting is attached in Annex 3.

Requirements for CIE Reviewers: Two CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. CIE reviewers shall have working knowledge and recent experience in the application of fish population dynamics, stock assessment methods, and fishery survey design. Each CIE reviewer's duties shall not exceed a maximum of 14 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review during the panel review meeting scheduled in Seattle, Washington tentatively during April 4-5, 2012.

Statement of Tasks: Each CIE reviewer shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer information (full name, title, affiliation, country, address, email) to the COTR, who forwards this information to the NMFS Project Contact no later than the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the background documents, reports, foreign national security clearance, and other information concerning pertinent meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Foreign National Security Clearance: When CIE reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for CIE reviewers who are non-US citizens. For this reason, the CIE reviewers shall provide requested information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/sponsor.html).

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewers the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

Panel Review Meeting: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. Modifications to the SoW and ToRs cannot be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COTR and CIE Lead Coordinator. Each CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the ToRs as specified herein. The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The NMFS Project Contact is responsible for ensuring that the Chair understands the contractual role of the CIE reviewers as specified herein. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Other Tasks – Contribution to Summary Report: Each CIE reviewer may assist the Chair of the panel review meeting with contributions to the Summary Report, based on the terms of reference of the review. Each CIE reviewer is not required to reach a consensus, and should provide a brief summary of the reviewer's views on the summary of findings and conclusions reached by the review panel in accordance with the ToRs.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the Schedule of Milestones and Deliverables.

1. Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.

2. Participate in the panel review meeting in Seattle, Washington during April 4-5, 2012.

3. In Seattle, Washington during April 4-5, 2012 as specified herein, conduct an independent peer review in accordance with the ToRs (Annex 2).

4. No later than 20 April 2012, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Manoj Shivlani, CIE Lead

Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, via email to David Die ddie@rsmas.miami.edu. Each CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in Annex 2.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

5 March 2012	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
21 March 2012	NMFS Project Contact sends the CIE Reviewers the pre-review documents
4-5 April 2012	Each reviewer participates and conducts an independent peer review during the panel review meeting
20 April 2012	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
4 May 2012	CIE submits CIE independent peer review reports to the COTR
11 May 2012	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: This 'Time and Materials' task order may require an update or modification due to possible changes to the terms of reference or schedule of milestones resulting from the fishery management decision process of the NOAA Leadership, Fishery Management Council, and Council's SSC advisory committee. A request to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent changes. The Contracting Officer will notify the COTR within 10 working days after receipt of all required information of the decision on changes. The COTR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COTR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COTR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COTR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:

(1) each CIE report shall completed with the format and content in accordance with Annex 1,

(2) each CIE report shall address each ToR as specified in Annex 2,

(3) the CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COTR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COTR. The COTR will distribute the CIE reports to the NMFS Project Contact and Center Director.

Support Personnel:

William Michaels, Program Manager, COTR
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Key Personnel:

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Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including providing a brief summary of findings, of the science, conclusions, and recommendations.

b. Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.

c. Reviewers should elaborate on any points raised in the Summary Report that they feel might require further clarification.

d. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

e. The CIE independent report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include the following appendices:

Appendix 1: Bibliography of materials provided for review

Appendix 2: A copy of the CIE Statement of Work

Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

Annex 2: Tentative Terms of Reference for the Peer Review

2012 NWFSC Southern California Shelf Rockfish Hook and Line Survey

- The overall goal of this review is to evaluate whether the design, protocols, and analytical methods developed for the NWFSC's hook and line survey are suitable for achieving the survey's objectives. The survey's primary objective is to generate information for use in stock assessments of structure-associated rockfish, particularly those species which are poorly sampled by trawl gear used in coast-wide surveys. Such information includes fishery-independent indices of abundance as well as biological data on size, age and maturity.

- Review recent literature (to be provided as background materials) to become familiar with the key species and the primary science and management issues within the Pacific Fishery Management Council (PFMC) umbrella for groundfish in general and structure-associated shelf rockfish in particular.

- Evaluate the suitability of the survey sampling design. Specifically, is the design appropriate for generating abundance indices for shelf rockfish species?
    - Comment on the benefits and drawbacks of the current fixed-site design. Are there benefits to replace or modify the survey's existing fixed-site design with one that includes a random component? If so, do the benefits outweigh the drawbacks associated with disrupting the continuity of the survey's current 8-year time series?

  - Evaluate the appropriateness of the gear used during the hook and line survey: rod and reel, mainline, gangion specifications, terminal tackle specifications, etc.

  - Evaluate the fishing and biological sampling protocols used during the hook and line survey

  - Evaluate the methods and assumptions used to analyze the survey data as well as the associated uncertainty of the abundance estimates.

  - Evaluate the utility of hook and line survey data for species encountered consistently at a subset of sites, but for which the survey's coverage may be near the margins of their range (e.g., copper rockfish, widow rockfish, yellowtail rockfish) and other species we encounter episodically in each survey year (e.g, chilipepper). Identify modifications to the survey's design, protocols, or analyses which may improve the utility of survey data for stock assessments of additional species.

- Potential survey expansion and other possible enhancements or modifications to the survey which could lead to additional objectives

- Does the current design lend itself to expansion?
- Evaluate whether expanding the survey's sampling area would yield information useful for the assessment of structure associated rockfish
- What are the scientific benefits and drawbacks of expanding the survey into adjacent areas currently not included in the survey area such as north of Pt. Conception or into the Cowcod Conservation Areas?
  - Would the methods used by this survey be effective for collecting data and generating abundance indices for other structure-associated rockfish with high commercial or recreational importance elsewhere along the coast (e.g., yelloweye rockfish off the WA or OR coast?)
- Final panel report
  - The report will be divided into sections corresponding to design, protocols, analysis, and survey expansion. Each section should contain the reviewers' understanding of the survey's objectives for that component, followed by analysis and commentary, strengths/weaknesses, and recommended changes/modifications (if any). We also request a prioritization of recommended changes and an evaluation of the potential repercussions if the recommendations cannot be implemented due to budget constraints.

Annex 3: Tentative Agenda

2012 Hook & Line Survey Review Panel Meeting

Seattle, Washington

Wednesday, April 4, 2012

8:00-8:30: Welcome, Introductions, and Objectives of the Review Panel

8:30-9:45: Presentation on Survey Background, Rationale, Objectives, and Design

9:45-10:30: Presentation on Survey Operations and Sampling Protocols

10:30-10:45: Break

10:45-12:00: Discussion of Presented Material

12:00-1:15: Lunch

1:15-2:00: Presentation on Analytical Methods

2:00-3:00: Discussion of Analytical Methods

- Basic approach
- Model selection

3:00-3:15: Break

3:30-4:30: Continued Discussion of Analytical Methods

- Variance estimation
- Power analysis

4:30: Meeting ends for the day.

Thursday, April 5, 2012

8:00-8:15:	Re-cap of Yesterday's Discussion

8:30-10:15:	Continued Discussion on Analytical Methods and all Presented Material

10:30-10:45:	Break

10:15-11:00:	Presentation on Potential Survey Expansion

11:00-12:00:	Discussion of Potential Survey Expansion

12:00-1:15:	Lunch

1:15-2:00:	Continued Discussion of Potential Survey Expansion

2:00-3:00:	Additional Discussion (Open Topic; as Necessary)

3:00-3:30:	Instruction to Panel on Final Reports

3:30pm:	Meeting Adjourns

Appendix 3: Panel Membership or other pertinent information from the panel review meeting

Appendix 3: Panel Membership

Review Panel

Chair: Mark Wilkins, AFSC (ret.)

Noel Cadigan (CIE)

Sven Kupschus (CIE)

Hook & Line Survey Team

Matt Barnhart (PSMFC/NWFSC)

Jim Benante (PSMFC/NWFSC)

John Harms (NOAA/NWFSC)

Ian Stewart (NOAA/NWFSC)

John Wallace (NOAA/NWFSC)

Other Participants

Aimee Keller (NOAA/NWFSC)

Patty Burke (NOAA/NWFSC)

Michelle McClure (NOAA/NWFSC)

Capt. Joe Villareal (FV Mirage)

Capt. Mike Thompson (FV Aggressor)